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PROCESS TO MAKE DECISION ON WHEN TO ALTER UPSTREAM BURST PROFILE BASED UPON PACKET LOSS PERCENTAGE USING HYSTERESIS THRESHOLDS
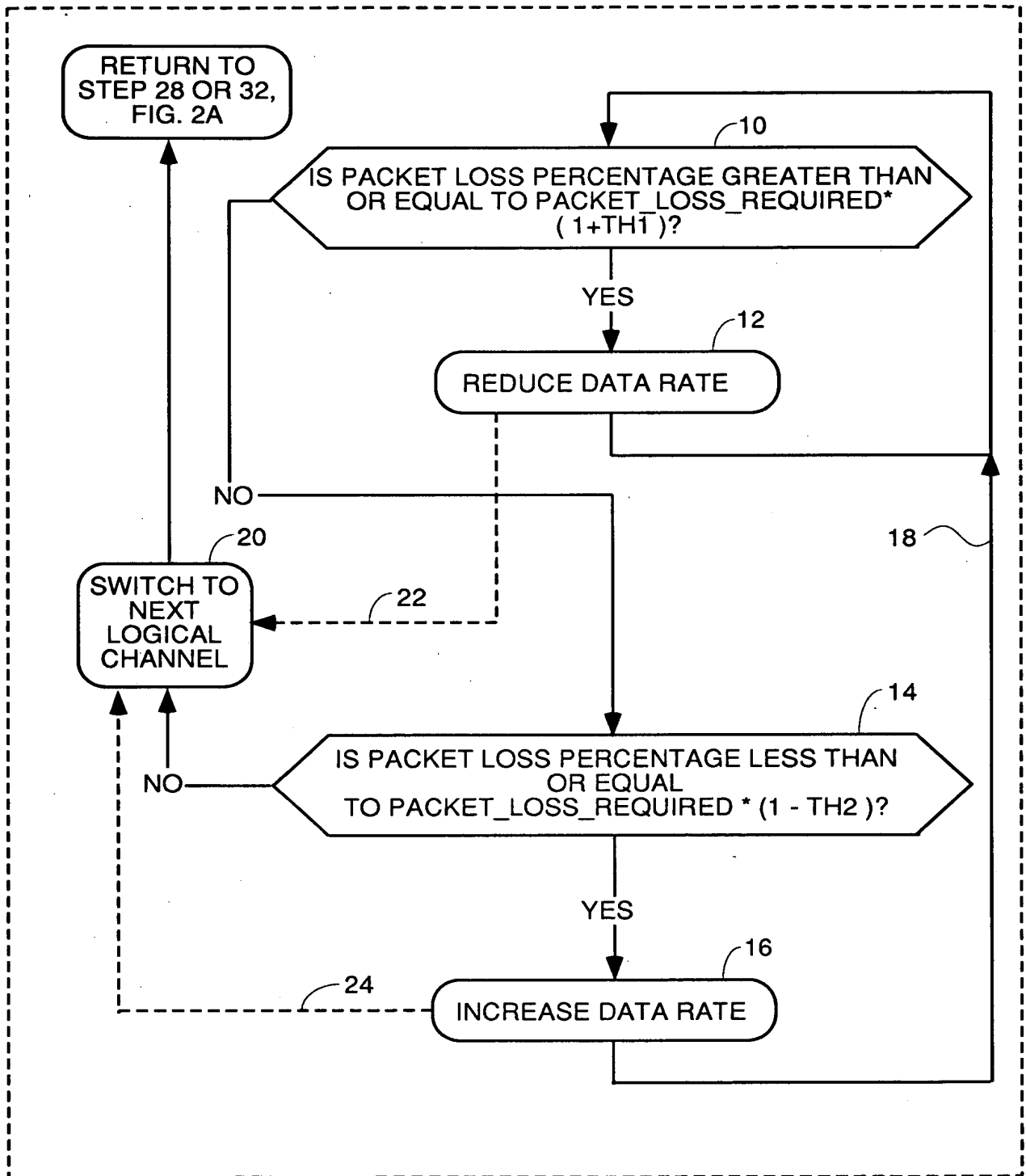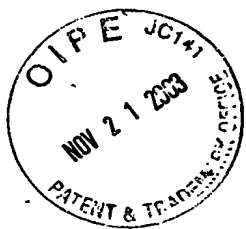
RETURN TO STEP 28 OR 32, FIG. 2A

10

IS PACKET LOSS PERCENTAGE GREATER THAN OR EQUAL TO PACKET_LOSS_REQUIRED* (1+TH1)?

YES

12

REDUCE DATA RATE

NO

20

SWITCH TO NEXT LOGICAL CHANNEL

22

18

14

NO

IS PACKET LOSS PERCENTAGE LESS THAN OR EQUAL TO PACKET_LOSS_REQUIRED * (1 - TH2)?

YES

16

24

INCREASE DATA RATE

FIG. 1

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CMTS PROCESSING FOR AUTOMATIC RATE ADAPTATION WITH CHANGING NOISE

FIG. 2A

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FROM FIG. 2A

42

CHANGE IN DATA RATE REQUIRED?

YES

44

SEND MESSAGE TO
APPROPRIATE PROCESS TO
CHANGE DATA RATE

46

SELECT BURST PROFILE FROM TABLE FOR NEXT
DATA RATE UP OR NEXT DATA RATE DOWN, AS
APPROPRIATE, GENERATE NEW UCD MESSAGE FOR
THE LOGICAL CHANNEL AND TRANSMIT, OR DISPLAY
ALERT TO CABLE OPERATOR SUGGESTING DATA RATE
CHANGE

FIG. 2B

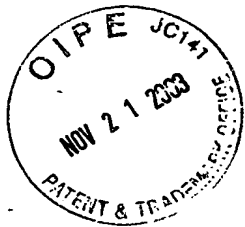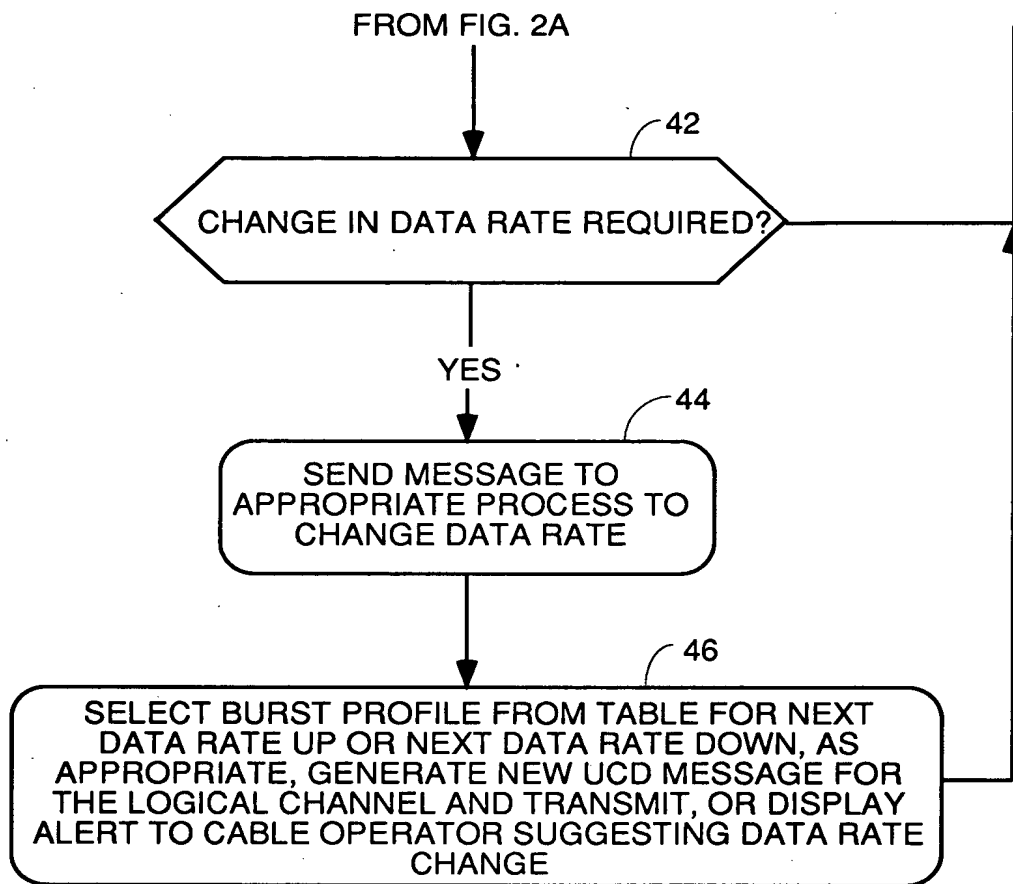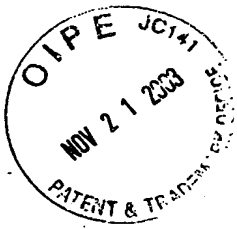## CMTS PROCESSING FOR AUTOMATIC RATE ADAPTATION WITH CHANGING NOISE

FIG. 3A

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FROM FIG. 3A

62

CHANGE IN DATA RATE REQUIRED?

YES

64

SEND MESSAGE TO
APPROPRIATE PROCESS TO
CHANGE DATA RATE

66

SELECT BURST PROFILE FROM TABLE FOR NEXT
DATA RATE UP OR NEXT DATA RATE DOWN, AS
APPROPRIATE, GENERATE NEW UCD MESSAGE FOR
THE LOGICAL CHANNEL AND TRANSMIT, OR DISPLAY
ALERT TO CABLE OPERATOR SUGGESTING DATA RATE
CHANGE

68

FIG. 3B

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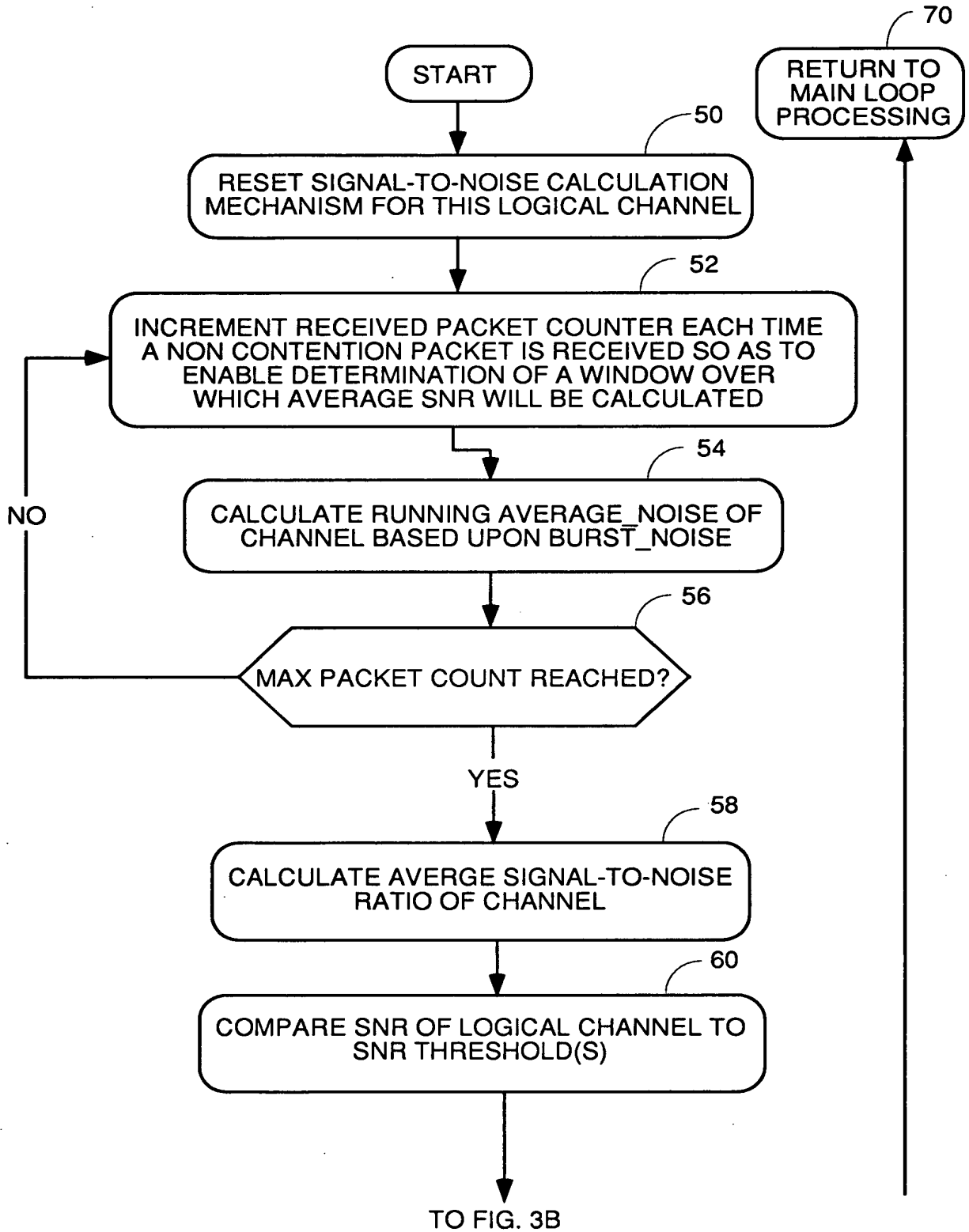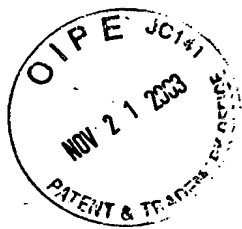Title: METHOD AND APPARATUS FOR AUTOMATIC RATE ADAPTATION IN A   DOCSIS UPSTREAM
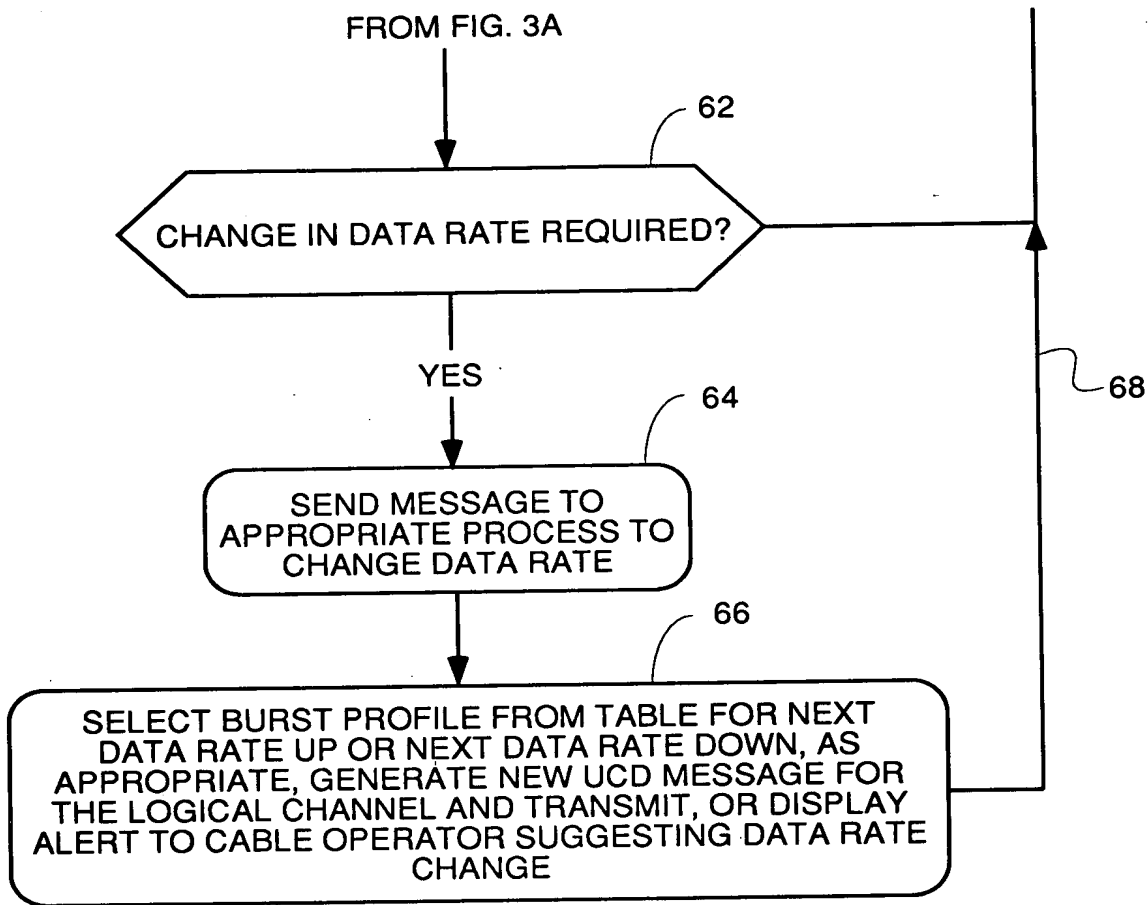
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PROCESS FOR AUTOMATIC RATE ADAPTATION USING BIT ERROR RATE AND
BYTE ERROR RATE

72

START

92

RETURN TO
MAIN LOOP
PROCESSING

74

RESET TOTAL FLAWED CODEWORD
COUNTER / ACCUMULATOR TO ZERO AND RESET
RECEIVED TOTAL RECEIVED CODEWORD
COUNTER TO ZERO FOR THIS LOGICAL
CHANNEL

76

ADD NUMBER OF CODEWORDS RECEIVED IN A
BURST TO RUNNING TOTAL OF RECEIVED
CODEWORDS EACH TIME A PACKET IS
RECEIVED

78

ADD NUMBER OF CODEWORDS WITH
UNCORRECTABLE ERRORS REPORTED BY THE R-S
DECODER FOR THE RECEIVED BURST TO THE
RUNNING TOTAL OF FLAWED CODEWORDS FOR THIS
LOGICAL CHANNEL AND THE PERTINENT INTERVAL

80

MAX COUNT REACHED?

NO

YES

82

DETERMINE THE BIT ERROR RATE OR BYTE
ERROR RATE OF THE LOGICAL CHANNEL BEING
PROCESSED

84

COMPARE BIT ERROR RATE OR BYTE
ERROR RATE OF LOGICAL CHANNEL TO
APPROPRIATE THRESHOLD(S)

TO FIG. 4B

FIG. 4A

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FROM FIG. 4A

86

CHANGE IN DATA RATE REQUIRED?

YES

88

SEND MESSAGE TO
APPROPRIATE PROCESS TO
CHANGE DATA RATE

90

SELECT BURST PROFILE FROM TABLE FOR NEXT
DATA RATE UP OR NEXT DATA RATE DOWN, AS
APPROPRIATE, GENERATE NEW UCD MESSAGE FOR
THE LOGICAL CHANNEL AND TRANSMIT, OR DISPLAY
ALERT TO CABLE OPERATOR SUGGESTING DATA RATE
CHANGE

FIG. 4B

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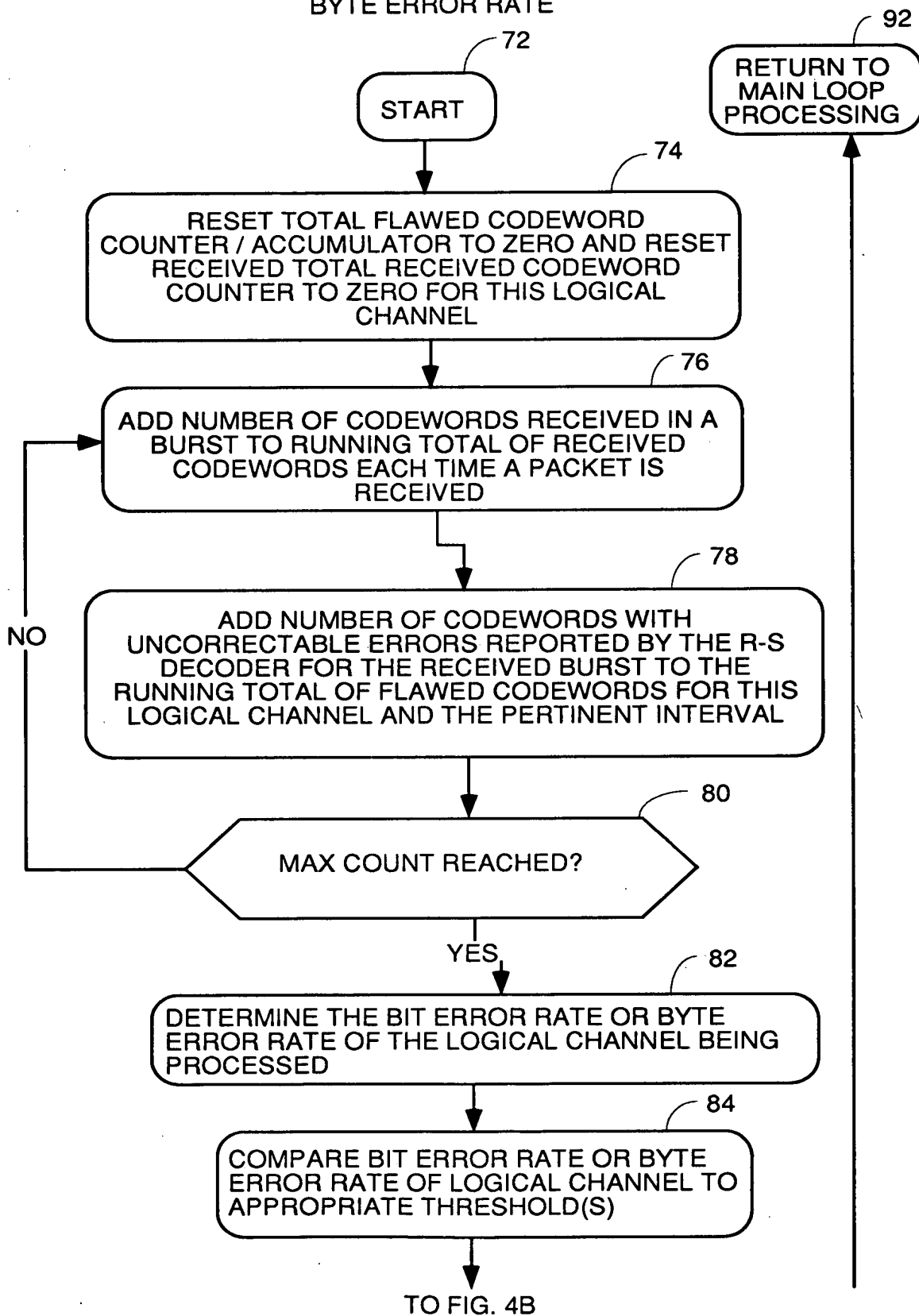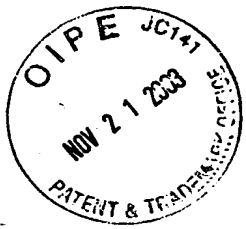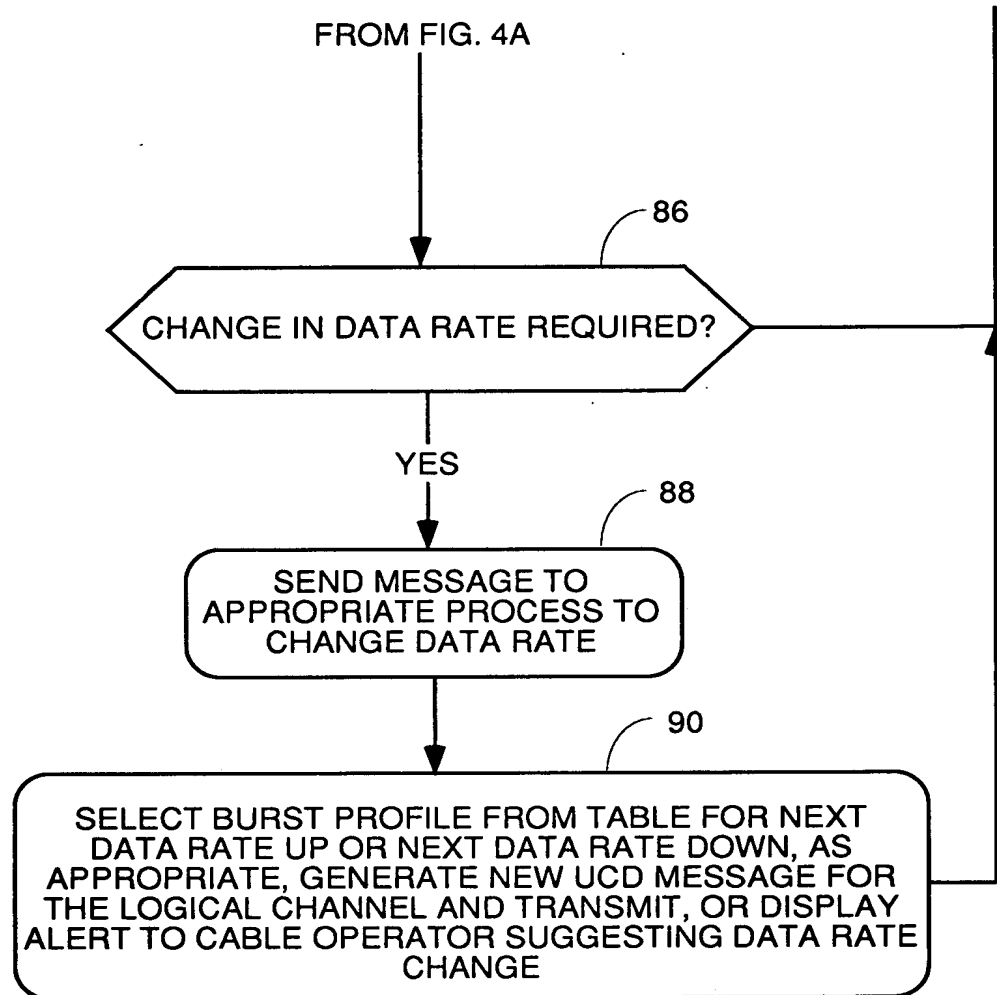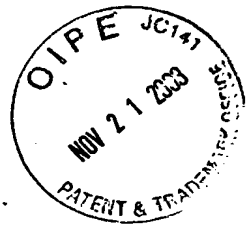
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GENERIC PROCESS TO AUTOMATICALLY DETECT THE NEED TO ADAPT
BIT RATE TO NOISE CONDITIONS ON A LOGICAL CHANNEL AND
AUTOMATICALLY CHANGE BIT RATE

POWERUP — 82

84

DETERMINE TYPE OF PREVALENT NOISE
CONDITIONS ON THE LOGICAL CHANNEL BEING
PROCESSED AND SELECT THE APPROPRIATE
TABLE OF BURST PROFILES BASED UPON
CHANNEL'S PREVALENT NOISE CONDITIONS.
CALCULATE THE SNR OF THE CHANNEL.

86

SELECT AN INITIAL BURST PROFILE
FROM THE APPROPRIATE TABLE OF
BURST PROFILES

88

CALCULATE OR DETERMINE A QUALITY OF
CHANNEL PARAMETER SUCH AS PACKET LOSS
PERCENTAGE OR SIGNAL-TO-NOISE RATIO, OR
BIT ERROR RATE OR BYTE ERROR RATE

90

COMPARE QUALITY OF CHANNEL PARAMETER
TO THRESHOLD(S)

92

BIT RATE CHANGE RECOMMENDED? — NO →

YES

94

CHANGE BIT RATE AND GENERATE AND SEND
NEW UCD MESSAGE

98

OPTIONALLY:
SELECT
ANOTHER
LOGICAL
CHANNEL IF
THERE IS
ONE

96

RETURN TO
OTHER
PROCESSING
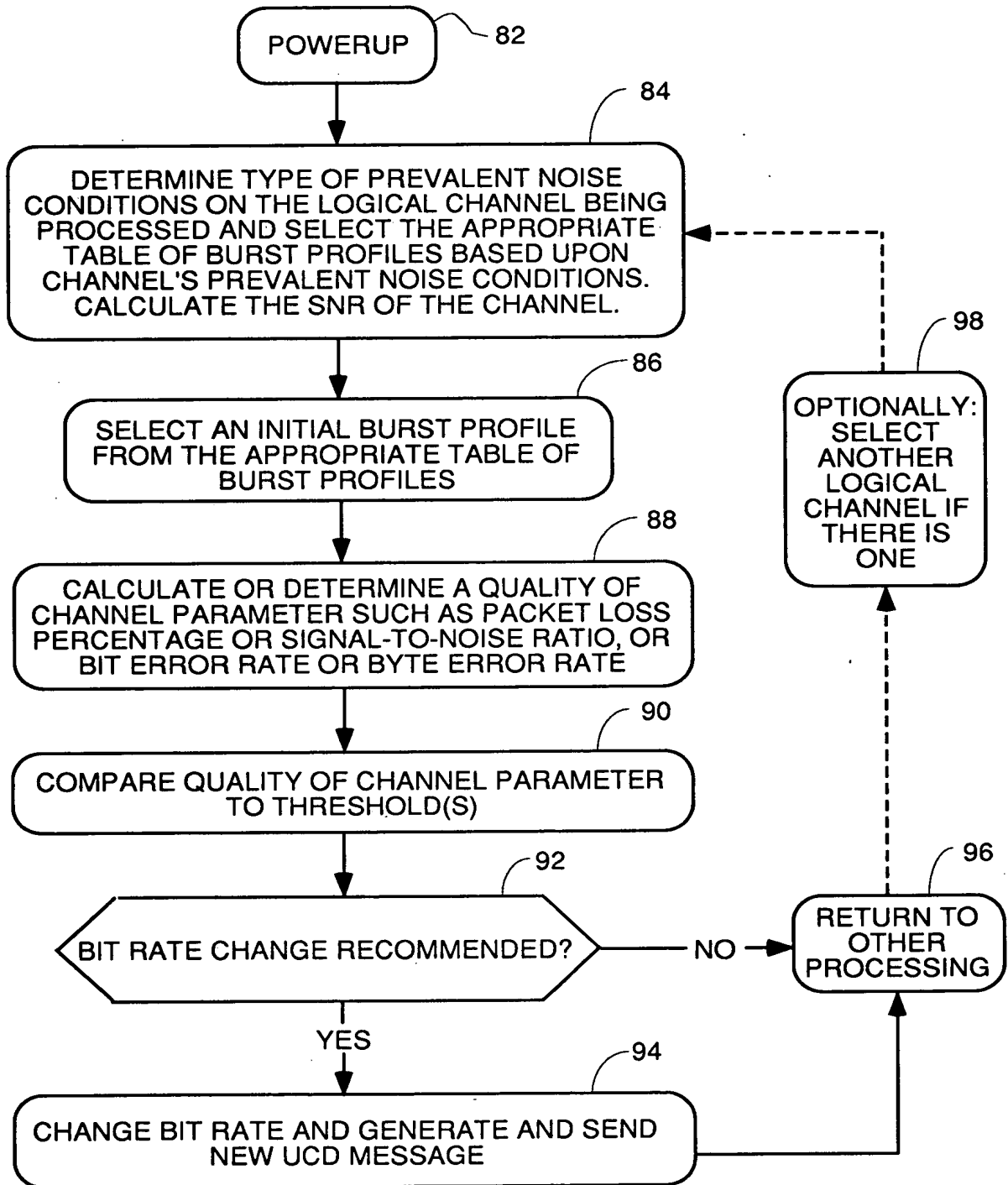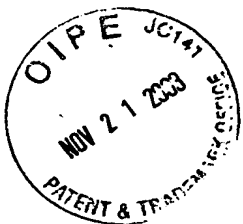
FIG. 5

GENERIC PROCESS TO AUTOMATICALLY DETECT THE NEED TO ADAPT BIT
RATE TO NOISE CONDITIONS ON A LOGICAL CHANNEL AND
GENERATE MESSAGE

POWERUP —— 82
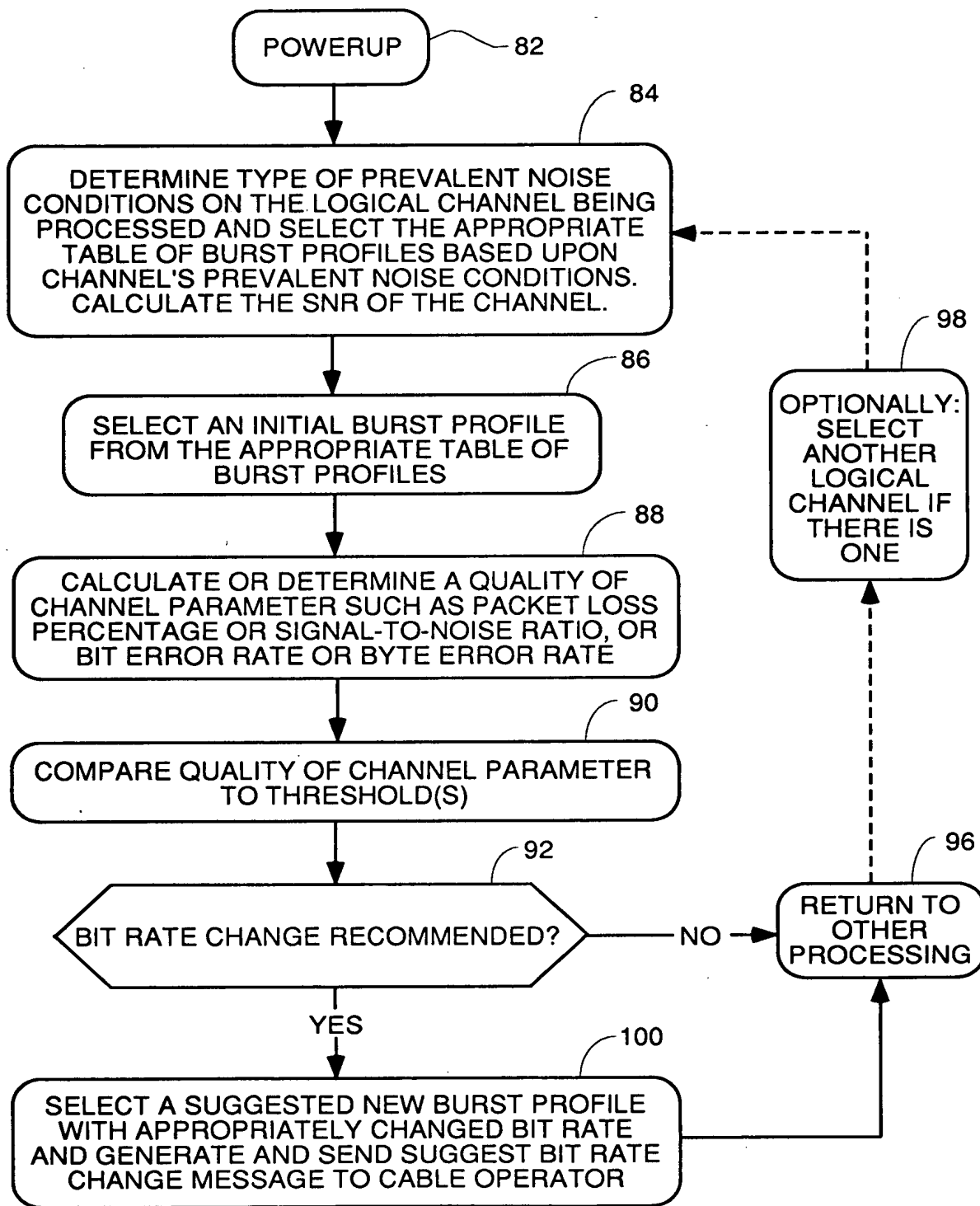
84

DETERMINE TYPE OF PREVALENT NOISE
CONDITIONS ON THE LOGICAL CHANNEL BEING
PROCESSED AND SELECT THE APPROPRIATE
TABLE OF BURST PROFILES BASED UPON
CHANNEL'S PREVALENT NOISE CONDITIONS.
CALCULATE THE SNR OF THE CHANNEL.

98

OPTIONALLY:
SELECT
ANOTHER
LOGICAL
CHANNEL IF
THERE IS
ONE

86

SELECT AN INITIAL BURST PROFILE
FROM THE APPROPRIATE TABLE OF
BURST PROFILES

88

CALCULATE OR DETERMINE A QUALITY OF
CHANNEL PARAMETER SUCH AS PACKET LOSS
PERCENTAGE OR SIGNAL-TO-NOISE RATIO, OR
BIT ERROR RATE OR BYTE ERROR RATE

90

COMPARE QUALITY OF CHANNEL PARAMETER
TO THRESHOLD(S)

92

BIT RATE CHANGE RECOMMENDED? —— NO →

96

RETURN TO
OTHER
PROCESSING

YES

100

SELECT A SUGGESTED NEW BURST PROFILE
WITH APPROPRIATELY CHANGED BIT RATE
AND GENERATE AND SEND SUGGEST BIT RATE
CHANGE MESSAGE TO CABLE OPERATOR

FIG. 6

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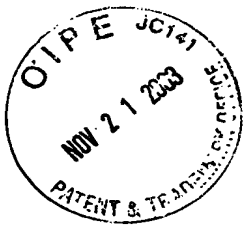
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FIG. 7

EXAMPLE OF BURST PROFILES OF DATA FOR DIFFERENT AWGN SNR FOR DOCSIS 1.X

#	USE FOR IMPULSE NOISE CHANNEL YES/NO	% BIT RATE FROM MAX	NET DATA RATE @ 2.56 MSPS	MODULATION	RS		
1	y	22%	2.3 Mbps	QPSK	k=16, t=10		
2	y	29%	3.0 Mbps	QPSK	k=28, t=10		
			~~3.8 Mbps~~	~~QPSK~~	~~k=58, t=10~~		
3	y	39%	4.0 Mbps	QPSK	k=78, t=10		
4	n	46%	4.7 Mbps	QPSK	k=235, t=10		
5	y	50%	5.1 Mbps	16-QAM	k=20, t=10		
			~~6.0 Mbps~~	~~16-QAM~~	~~k=28, t=10~~		
6	y	62%	6.4 Mbps	16-QAM	k=39, t=10		
			~~7.5 Mbps~~	~~16-QAM~~	~~k=55, t=10~~		
7	y	79%	8.1 Mbps	16-QAM	k=78, t=10		
8	y	92%	9.4 Mbps	16-QAM	k=235, t=10		
9	n	100%	10.24 Mbps	16-QAM	k=16, t=0		

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FIG. 8

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Title: METHOD AND APPARATUS FOR AUTOMATIC RATE ADAPTATION IN A   DOCSIS UPSTREAM
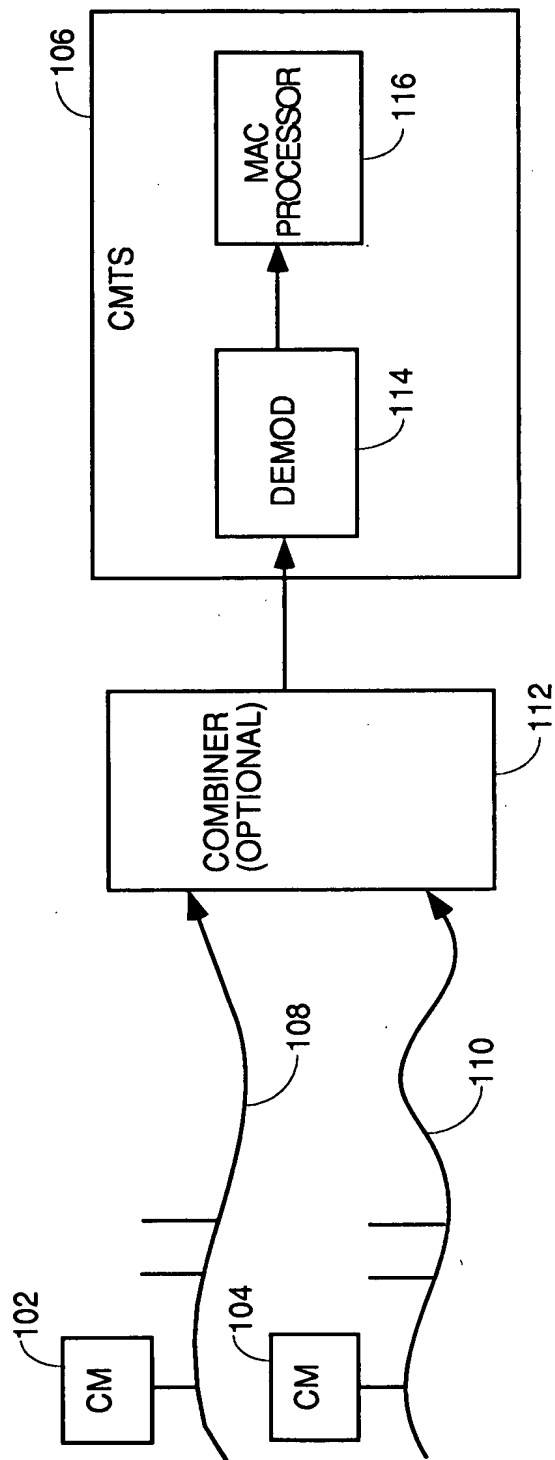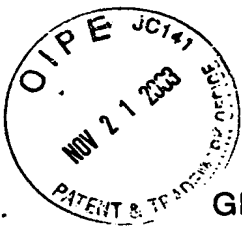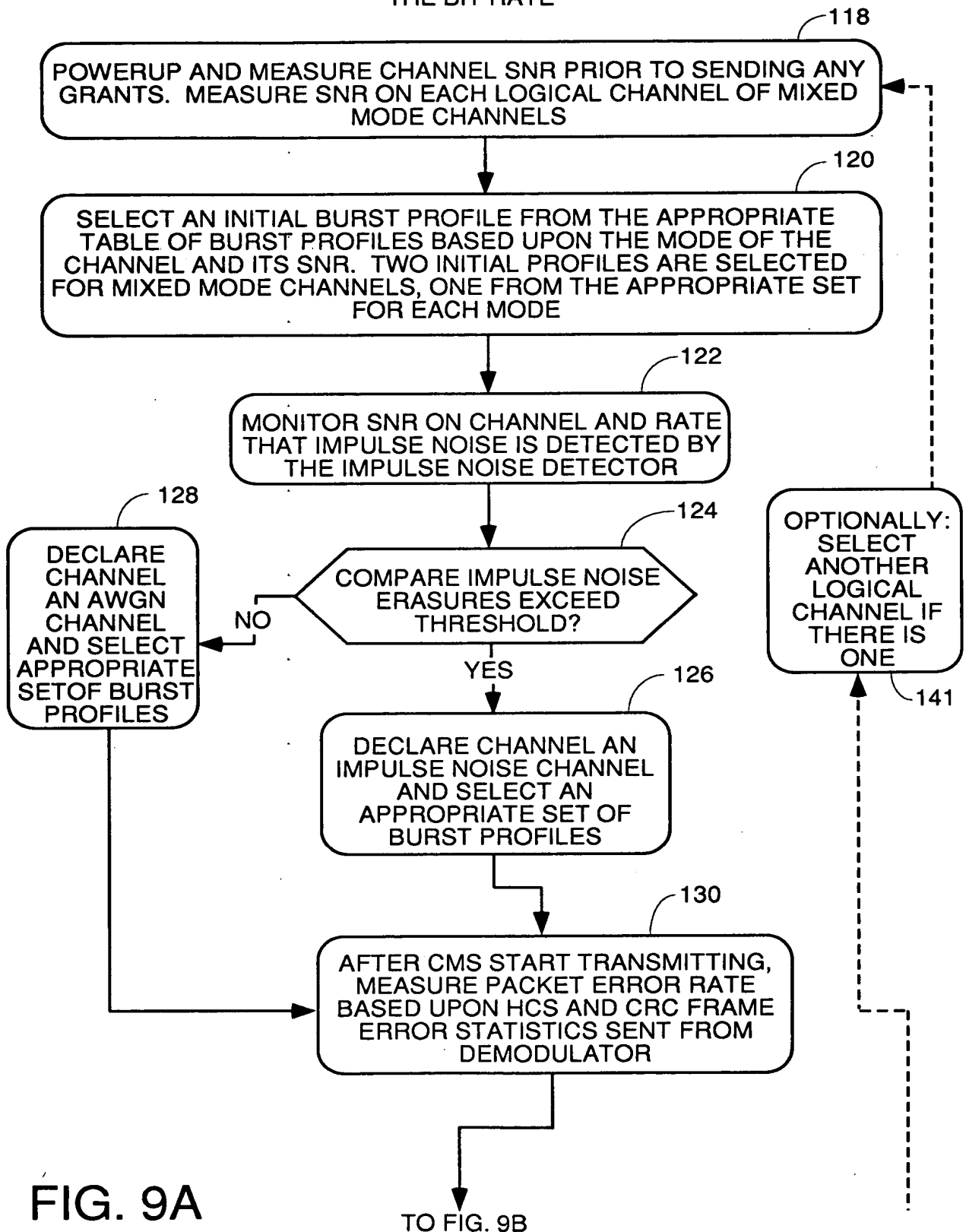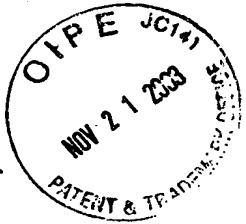
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GENERIC PROCESS TO AUTOMATICALLY DETECT THE NEED TO ADAPT BIT
RATE TO NOISE CONDITIONS ON A LOGICAL CHANNEL AND ADJUST
THE BIT RATE

118
POWERUP AND MEASURE CHANNEL SNR PRIOR TO SENDING ANY
GRANTS. MEASURE SNR ON EACH LOGICAL CHANNEL OF MIXED
MODE CHANNELS

120
SELECT AN INITIAL BURST PROFILE FROM THE APPROPRIATE
TABLE OF BURST PROFILES BASED UPON THE MODE OF THE
CHANNEL AND ITS SNR. TWO INITIAL PROFILES ARE SELECTED
FOR MIXED MODE CHANNELS, ONE FROM THE APPROPRIATE SET
FOR EACH MODE

122
MONITOR SNR ON CHANNEL AND RATE
THAT IMPULSE NOISE IS DETECTED BY
THE IMPULSE NOISE DETECTOR

128
DECLARE
CHANNEL
AN AWGN
CHANNEL
AND SELECT
APPROPRIATE
SETOF BURST
PROFILES

NO

124
COMPARE IMPULSE NOISE
ERASURES EXCEED
THRESHOLD?

YES

126
DECLARE CHANNEL AN
IMPULSE NOISE CHANNEL
AND SELECT AN
APPROPRIATE SET OF
BURST PROFILES

OPTIONALLY:
SELECT
ANOTHER
LOGICAL
CHANNEL IF
THERE IS
ONE

141

130
AFTER CMS START TRANSMITTING,
MEASURE PACKET ERROR RATE
BASED UPON HCS AND CRC FRAME
ERROR STATISTICS SENT FROM
DEMODULATOR

FIG. 9A

TO FIG. 9B

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FROM FIG. 9A

132

BIT RATE CHANGE RECOMMENDED? —NO→

139

RETURN TO OTHER PROCESSING

YES

134

PICK A NEW BURST PROFILE WITH A PROPERLY SELECTED BIT RATE TO MAINTAIN THE PACKET ERROR RATE WITHIN A PACKET ERROR RATE REQUIREMENT, AND GENERATE AND SEND A NEW UCD MESSAGE FOR THE NEW BURST PROFILE

136

REPEAT PER MONITORING PROCESS DESCRIBED ABOVE STARTING WITH STEP 122

SUCCESS

137

NO

138

HAVE PREDETERMINED NUMBER OF CYCLES THROUGH THE MONITORING PROCESS BEEN COMPLETED WITHOUT BRINGING THE PER WITHIN THE DESIRED PER REQUIREMENT?

140

JUMP TO ANOTHER LOGICAL CHANNEL BY SENDING NEW MAP AND UCD MESSAGES TO CMS

FIG. 9B